Low Educational Status is a Risk Factor for Mortality Among Diabetic People

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Diabetes mellitus and its complications are an important cause of mortality in Western populations. The purpose of the present study was to examine the relationship between self-reported diabetes mellitus, gender, attained level of education, and socio-economic resources to all-cause mortality risk in a simple random sample of 39 055 subjects, aged 25 to 74 years. Follow-up data were obtained for a maximum of 16 years, from baseline (1979–1985) to 31 December 1995. Diabetic males (2.2 % of the male study group) had a relative risk (RR) for total mortality of 2.24 (CI = 1.96–2.57), adjusted for age, education, marital status, housing tenure, and car ownership, compared with non-diabetic males. The corresponding figure for females with diabetes (1.9 %) was RR = 3.67 (CI = 3.16–4.27). Diabetic women had the highest age-adjusted mortality risk for coronary heart disease (CHD) of 8 compared with non-diabetic women. The corresponding RR for men was just below 3 ($p<0.0001$). Males and females (with and without diabetes) of low attained educational level had a RR = 1.26 (CI = 1.15–1.39) and RR = 1.54 (CI = 1.31–1.81), respectively. When analysing all people with diabetes separately, adjusting for sex and age, low-educated subjects had a 40 % excess all-cause mortality compared with high-educated subjects. We conclude that diabetic women have a very high relative risk for CHD mortality compared to non-diabetic women. Furthermore, diabetic people with a low attained level of education, have an increased vulnerability to, and a higher total mortality. © 1998 John Wiley & Sons, Ltd.

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Introduction

Diabetes mellitus is a chronic disease with well-documented chronic complications and increased mortality rate with increasing disease duration.[1] Other predictors of mortality in diabetes are age and sex of the patient, as well as the presence of concomitant cardiovascular risk factors, such as hypertension, dyslipidaemia, and smoking.[2] Recently, psychosocial and socio-economic factors have been suggested as important risk factors for diabetes complications.[3,4] Davis *et al*.[3] reported that the social impact of diabetes correlated independently with survival in a group of 343 subjects with Type 2 (non-insulin-dependent) diabetes, while Connolly and Kesson found that Type 2 diabetic patients from areas of low socio-economic status are at increased risk of cardiovascular disease.[4] Other investigators have reported a more pronounced cardiovascular risk factor profile in subjects with Type 1 (insulin-dependent) or Type 2 disease from low than from high social class,[5,6] thus explaining a higher overall risk in people with diabetes in a lower socio-economic group. Better educated males with Type 1 diabetes have also been shown to have a lesser degree of microvascular complications than less educated diabetic males.[6] Taken together, this reflects patterns of class-related morbidity and mortality in the non-diabetic population.

Marital or cohabitation status is another aspect of social position that is proved to be associated with overall morbidity and mortality.[7] This, however, has not been well explored in people with diabetes.

In Sweden, previous epidemiological studies have documented local patterns of mortality rates in diabetes,[8,9] as well as the relation of baseline blood glucose, glucose tolerance, and clinical diabetes to prospective cardiovascular disease and death in women.[10] Socio-economic factors were not included in these studies.

Surveys have traditionally been used in the UK, Sweden, and the USA to obtain information on subjective ill-health. To a large extent these surveys have been based on the same questions, e.g. the first Swedish Level of Living Survey from 1968, the American Health Interview Surveys, the British General Household Survey, and the Swedish Annual Level-of-Living Surveys.[11] The present paper will focus on the long-term consequences

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of interactions between self-reported diabetes and social characteristics, based on a large national random sample of 39 055 subjects in Sweden. The first aim of the study was to investigate the association between self-reported diabetes and total mortality when adjusting for age, marital status, social class (education), and material resources for males and females separately. The second aim was to analyse the risks for deaths in coronary heart disease (CHD), cardiovascular disease (CVD) and circulatory disease in people with diabetes compared to their non-diabetic peers. The third aim was to analyse the risk of total mortality within the diabetic group at different levels of attained education.

Subjects and Methods

Registers Used

The Swedish Annual Level-of-Living Survey (SALLS) is based on a nationwide random sample of approximately 8000 persons (aged 16–84 years) per year.[11] The present study contains data from 39 055 subjects aged 25 to 74 years. The data were collected by Statistics Sweden, during a 7-year period 1979–1985 and the respondents constituted seven independent samples of the Swedish population drawn from the register of the total population. The interview usually took place in the respondent's home, and the average response rate was 85 %. The present study was designed as a follow-up study ranging from 1 January 1979 to 31 December 1995. Data on the dependent variable (mortality) was obtained from the Central Cause of Death Register, subdivided into different major causes of mortality. All respondents were linked to the Cause of Death Register by the Swedish personal 10-digit registration number. Person-years at risk were calculated from the date of the interview until death, or for those who survived, until the end of the follow-up period, providing a total of 5315 deaths during the period 1979 until 31 December, 1995. Other dependent variables were CHD (410–414), cerebrovascular diseases (430–438), and CVD (390–459).

Five independent variables, apart from sex and age, were defined:

1. Diabetes mellitus, based on the number of respondents who reported long-term illness because of diabetes mellitus. In all, 420 males (2.2 % of all males) and 356 females (1.8 % of all females) were identified as having diabetes, but no separation into Type 1 or Type 2 was possible due to lack of precise information.
2. Attained level of education (years of education), classified into three groups: (a) low ($<=$ 9 years), primary school;
   (b) medium (10–11 years), at most two years of high school;
   (c) high ($>$11 years), more than two years of high school, or university studies.
3. Marital status, dichotomized into those who were married or cohabiting, and those who were living alone.
4. Form of housing tenure, dichotomized into those who owned their own house or flat, and all others.
5. Car owner, dichotomized into those who owned a car, and all others.

Education was taken to be a proxy for the social class position of an individual. It is thus described by the second variable, and material resources by the fourth and fifth.

Statistical Analysis

The data were analysed by a proportional hazard model[12] by sex, in order to estimate the relative risks of total mortality. The results are presented as relative risks (RR) with 95 % confidence intervals (CI). All models are adjusted for age (not shown). As a measure of improvement in model fit, when including a covariate, the change in -2 log likelihood was used, the likelihood ratio test. If the *p*-value for the difference was <0.05, the extended model was considered as better. The proportional hazards assumption was analysed by inspecting log(–log) survival curves for parallelism. All included variables approximately met the assumption. There were no interactions between diabetic patients and any of the other independent variables. Time was defined as years from interview until death or until censoring at the end of the follow-up period. Standardized mortality rates (SMR) were calculated by the method of Breslow and Day.[13] Test of difference between diabetic and non-diabetic subjects was made by a chi-squared test. Age-specific death rates were calculated as number of deaths divided by years at risk multiplied by 1000.

Results

In all, 2.2 % of the males and 1.9 % of the females reported diabetes. Sex-specific demographic data on age, educational level, marital status, and socio-economic resources for all subjects, and the percentage of people with diabetes in the total study group are given in Table 1. The highest percentages of people with diabetes were found among those with low attained level of education; those who lived alone; people not owning their home; and those who did not have access to a car. The differences in all variables between those with and those without diabetes were significant ($p<0.001$).

During the observation period, 3177 males and 2138 females died. The standardized mortality rate (SMR) in males with diabetes was 2.22 and in females with diabetes 3.38 compared to non-diabetic males (SMR = 1) and females (SMR = 1), respectively. The total number of risk-years was 243 500 for males and 259 600 for females. Table 2 shows the sex- and age-specific death rates per 1000 person-years in people with and without

Table 1. The distribution (%) of the independent variables by sex and percentage diabetic subjects (with 95 % confidence interval) in the different variables

Variable	Level	Males		Females	
		All	% Diabetics	All	% Diabetics
Total			2.2 (1.8–2.4)		1.9 (1.7–2.1)
Age (yr)	25–34	24.4	0.7 (0.5–0.9)	23.6	0.4 (0.2–0.6)
	35–44	23.9	0.9 (0.6–1.2)	22.0	0.6 (0.4–0.8)
	45–54	17.8	1.9 (1.4–2.4)	18.0	1.0 (0.7–1.3)
	55–64	18.7	3.6 (3.0–4.2)	19.1	2.6 (2.1–3.1)
	65–74	15.2	5.6 (4.8–6.4)	17.3	5.8 (5.0–6.4)
Education	Low	39.9	3.3 (2.9–3.7)	45.0	3.0 (2.7–3.3)
	Medium	27.2	1.7 (1.3–2.1)	32.4	1.4 (1.1–1.7)
	High	33.0	1.5 (1.2–1.8)	22.6	0.6 (0.4–0.8)
Marital status	Single-living	24.4	3.1 (2.6–3.6)	26.8	2.7 (2.2–3.2)
	Married/Cohabiting	75.6	2.0 (1.8–2.2)	73.2	1.6 (1.4–1.8)
Form of tenure	Renting	34.3	2.7 (2.3–3.1)	34.6	2.4 (2.0–2.8)
	Owner-occupied	65.7	2.0 (1.8–2.2)	65.4	1.7 (1.5–1.9)
Car owner	No	15.1	3.5 (2.8–4.2)	21.1	3.4 (2.8–4.0)
	Yes	84.9	2.0 (1.8–2.2)	78.9	1.5 (1.3–1.7)
Total number of subjects		18 825	420	19 454	356
Number of deaths		2952	225	1945	193

Table 2. Sex- and age-specific death rates (per 1000 person-years) in diabetic and non-diabetic persons (with 95 % confidence interval)

Age group (yr)	Males		Females	
	Diabetes	No diabetes	Diabetes	No diabetes
25–34	2.4 (0.0–7.1)	1.2 (0.9–1.5)	12.7 (0.0–26.9)	0.8 (0.6–1.0)
35–44	21.9 (9.0–34.8)	2.3 (1.9–2.7)	13.7 (1.7–25.7)	2.0 (1.7–2.3)
45–54	37.2 (23.2–51.2)	8.0 (7.2–8.8)	20.2 (7.0–33.4)	4.1 (3.5–4.7)
55–64	56.3 (42.8–69.8)	21.3 (19.9–22.7)	45.2 (32.0–58.4)	11.6 (10.6–12.6)
65–74	94.8 (77.8–111.8)	54.6 (51.9–57.3)	92.5 (76.7–108.3)	30.2 (28.4–32.0)

diabetes, revealing the highest differences (9.5 times higher death rates) in diabetic males compared with non-diabetic subjects in the ages 35–44.

The prevalence of causes of death and risk ratios (RR) in CHD, cerebrovascular disease, and all circulatory diseases are shown in Table 3. Diabetic women had the highest age adjusted RR of CHD mortality.

The age-adjusted (proportional hazard) models demonstrate that diabetes was independently associated with a high risk for mortality among men and especially high among women when adjusted for age, educational level, marital status, form of tenure, and car ownership (Table 4). Low or intermediate attained level of education, single living, form of tenure (non-ownership), and not being a

Table 3. Prevalence (%) of cause of deaths in CHD (410–414), cerebrovascular disease (430–438), circulatory diseases (390–459), and age-adjusted relative risks (RR) by sex, with non-diabetic persons as reference (RR = 1), with 95 % confidence interval

Cause of death	Sex	Non-diabetic subjects		Diabetic subjects	
		Prevalence	RR	Prevalence	RR
410–414	M	32.4	1	41.8 (31.8–51.8)	2.89 (2.34–3.57)
CHD	F	19.7	1	45.1 (34.6–55.6)	8.03 (6.34–10.18)
430–438	M	8.6	1	12.4 (0.2–24.6)	3.15 (2.13–4.67)
Cerebrovascular	F	10.8	1	13.5 (0.2–26.6)	4.37 (2.89–6.59)
390–459	M	51.5	1	62.7 (54.7–70.7)	2.73 (2.29–3.24)
Circulatory	F	41.2	1	70.0 (62.3–77.7)	5.99 (4.98–7.20)

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Table 4. The relative risk (RR) of total mortality with 95 % confidence intervals (CI) in the final models (proportional hazard model), adjusted for age in the ages 25-74 by sex. Males (n = 19 245), total number of deaths: 3177. Females (n = 19 810), total number of deaths: 2138

Variable	Level	Males		Females	
		RR	CI	RR	CI
Diabetes	Yes	2.24	1.96–2.57	3.67	3.16–4.27
	No	1	reference	1	reference
Education	Low	1.26	1.15–1.39	1.54	1.31–1.81
	Medium	1.23	1.10–1.37	1.28	1.08–1.52
	High	1	reference	1	reference
Marital status	Single	1.45	1.34–1.58	1.24	1.12–1.36
	Married or Cohabiting	1	reference	1	reference
Form of tenure	Renting	1.34	1.24–1.44	1.22	1.11–1.33
	Owner occupied	1	reference	1	reference
Car owner	No	1.28	1.18–1.39	1.18	1.07–1.30
	Yes	1	reference	1	reference

car-owner, were all associated with an increased all-cause mortality when adjusted for all background variables simultaneously.

Within the diabetic group, age-adjusted risk ratios for mortality were calculated in two models, of which one focused on education, adjusted for sex and age. The other model also included marital status, form of tenure, and car ownership as explanatory variables for mortality (Table 5). Diabetic people with low attained education level had an increased risk for mortality, RR = 1.41 (CI = 1.00–1.98) compared with those with high attained level of education in the first model. In the extended model, non-ownership of housing appeared to be the strongest variable associated with increased mortality risk within the diabetic group.

Discussion

The main finding in the present study is that diabetes is a risk factor for total mortality for both men and women, independent of social class (education), marital status or material resources (form of home tenure, car ownership). Further, diabetic women have a very high relative age-adjusted mortality risk for CHD, higher than men. Within the diabetic group, people with a low educational status had an increased total mortality risk.

The advantage of this study is the focus on a large, well-defined, random sample of the Swedish population. Another strength of the study is the longitudinal design and the low drop-out rates. By using the personal 10-digit register number, it was possible to follow each

Table 5. The relative risk (RR) of total mortality within the diabetic group with 95 % confidence interval (CI) in two proportional hazard models, adjusted for age in age 25–74 years, n = 776; number of deaths = 418

Variable	Level	Model 1		Model 2	
		RR	CI	RR	CI
Sex	Male	1.16	0.96–1.42	1.20	0.98–1.46
	Female	1	reference	1	
Education	Low	1.41	1.00–1.98	1.37	0.97–1.92
	Medium	1.27	0.86–1.87	1.27	0.86–1.88
	High	1	reference	1	
Marital status	Single			1.06	0.86–1.31
	Married or cohabiting			1	reference
Form of tenure	Renting			1.62	1.32–1.98
	Owner			1	reference
Car owner	No			0.97	0.78–1.21
	Yes			1	reference

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person from the time of the interview to death or to censoring on 31 December 1995. An obvious limitation of the present study is the lack of information on the duration and classification of diabetes before and after the interviews. However, this type of survey has a long tradition and experience; the questions were well validated and have been consistent over the years[14] and also have a high reliability.[15] They were constructed to give an objective description of living conditions in Sweden.

The finding that diabetes was associated with an increased mortality risk independent of social class (education), marital status, and material resources is new and important, as the present study is based on a representative large random sample of the Swedish population. The increase in total mortality risk was considerable, reaching a maximum of nearly 10 when the risk for mortality for a diabetic women was multiplied by factors such as single living, low educational status, and low material resources.

Furthermore, this population-based study has shown that within the diabetic group, people of low social class, i.e. low attained level of education, had an increased mortality risk. A recent hospital-based study in selected Type 1 diabetic subjects also showed an association between low socio-economic status and all-cause mortality over 10 years.[16] In contrast, a recent Finnish study did not show an increased mortality risk after 5 years' follow-up in diabetic subjects of low social compared to high social class, defined by occupation only and with farmers excluded.[17] The study included males and females of comparable age but only looked at people treated with drugs. Self-reported diabetes, as in our study, may detect more cases of diabetes, including those forms treated with diet only. Educational level and the determination of socio-economic resources may also be more relevant for the classification of social class than occupational status, at least in the Nordic countries, as occupation may be subject to more frequent changes during lifetime than educational level. In national registers, educational level may also be obtained from more of the population, including farmers, subjects with occupations that may be difficult to classify, and those who are unemployed.

Diabetes mellitus is a chronic disease condition with widespread social implications for the patient, as well as restrictions in daily life. A cluster of cardiovascular risk factors in diabetes in low social class has previously been reported in epidemiological studies,[3,4,6] and the impact of psychosocial factors on diabetes complications has been described in Type 1 patients.[6] There is also ample evidence of a change in the social distribution of diabetes during this century, from being more prevalent in upper, affluent social classes in the early part of the century to becoming more prevalent in lower social classes.[18] This is accompanied by a similar trend for obesity and other diabetes-associated risk factors for cardiovascular disease.[19,20]

The finding of an 8 times higher relative risk for CHD mortality in women and a 3 times higher relative risk for men, compared to non-diabetic subjects of the same sex, accords well with numerous reports in the medical literature.

What are the possible causal links between social class and diabetes mortality? Genetic or social selection may play a role, including the relationship between low birthweight and the future development of diabetes.[21–23] This mechanism may explain the occurrence of an increased risk of diabetes and premature adult mortality in lower social classes, where low birth weight is also more prevalent.[24] Lifestyle variables are also of great importance, e.g. smoking habits. Maternal smoking may increase the risk of fetal malnutrition and low birthweight[25] and thereby adverse programming for adult disease, but adult smoking is also in itself a risk factor for both Type 2 diabetes[26–28] and cardiovascular disease.[29]

Psychosocial stress, associated with social class, is sometimes hard to define and measure. There exist, however, several links between psychosocial stress and cardiovascular disease, but also with abdominal obesity[30] and insulin resistance,[31] two well-known risk factors for Type 2 diabetes. Stress and stress reactions have been associated with a negative influence on glucose metabolism in diabetes, perhaps mediated by insulin-antagonist hormones.[32–37] Stress-related factors may contribute to a process of premature ageing of the body,[38] which is evident in both diabetes mellitus and smoking, two models of premature morbidity and mortality. Furthermore, a stressful psychiatric condition like major depression has also been shown to be a risk factor for the onset of Type 2 diabetes.[39]

Female sex is commonly not a risk factor for early mortality due to the protection by oestrogen in the premenopausal state. In diabetes, however, this protection seems to be partially lost and female mortality is thus substantially increased in comparison with non-diabetic females.[40,41] In our study the age-adjusted relative mortality risk of females with diabetes was higher than that of corresponding men with diabetes in the low education group, but an opposite sex pattern was seen for marital status (single living) and lack of socio-economic resources (Table 4). The interpretation would be that females with diabetes are more vulnerable if of low level of attained education, and diabetic males more vulnerable if lacking social networks and socio-economic resources. The interaction between social class and female sex has been explored,[42] but, to the best of our knowledge, no data exist specifically for diabetes, except for one Finnish study.[17] Our findings thus further support the need for educational efforts directed to females and males with a low level of educational attainment, to improve diabetes self-management and knowledge and thereby counteract health inequities in this field.

In conclusion, this follow-up study showed that diabetes was an independent risk factor for all-cause mortality, especially among women. The relative mortality

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risk is increased in those who are less well educated, single living, and lacking socio-economic resources. As a group, people with diabetes had a lower level of attained education and poorer socioeconomic resources than their non-diabetic peers. Furthermore, low-educated diabetic people had a higher all-cause mortality than high-educated diabetic persons. This underscores the impression of diabetes mellitus (at least for Type 2) as a chronic disease of lower social classes with less education in developed Western countries.

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Note

Similar results on the association between low social class and increased mortality in diabetic people were recently published by N. Chaturvedi *et al*. in the *BMJ* 1998; **316**: 100–106. The authors of that paper used employment grade whereas we used educational status to characterise the social class of diabetic people.

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